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(54) Title: Polyester Conjugate Fiber

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CLAIMS

1. Polyester conjugate fiber characterized by comprising (A) a polymer that is essentially a single polyester and (B) polymer obtained by adding polymethacrylate and/or polystyrene to a polyester base, with the two polymers being adhered in many layers and satisfying the following conditions (1)-(3):

(1) the conjugate fiber has a C-shaped cross section;

(2) the amount of the additive used with the polyester base is 0.3-5 wt%;
(3) in the cross section of the conjugate fiber, polymer A and polymer B are adhered to each other in at least three layers.

2. Polyester conjugate fiber in accordance with Claim 1, wherein the weight ratio of polymer A and polymer B in the conjugate fiber is 20/80 to 80/20.

3. Polyester conjugate fiber in accordance with Claim 1, wherein the number of conjugating layers is 4-32.

DETAILED EXPLANATION OF THE INVENTION

The present invention concerns polyester conjugate fibers; it more specifically concerns inexpensive polyester conjugate fibers having a novel handle, especially displaying the crimp and handle of knit-deknit yarns.

Recently, with the diversity, high quality, and individuality of wearing apparel, processed yarns are also imparted the handle, aesthetics, and functionality of natural fibers, and various fiber products have been marketed, such as silky fibers, wooly fibers, spun-like fibers, etc.

On the other hand, in parallel with such trends, efforts have been made to lower the product cost, and various investigations have been under way, including increasing the spinning speed, drawing speed, processing speed, etc., or the continuation or omission of some processes.

However, putting these two trends together is rather difficult. For example, the process for making such processed yarns is in general very complex, and the production cost tends to be high.

The knit-deknit yarns lacking filament cross-sectional deformation and crimping twist deformation as false-twist yarns, yet having excellent luster properties, are favorably used in knit products for one-piece clothing, blouses, summer sweaters, etc. However, such knit-deknit yarns are obtained by knitting a drawn yarn from a nondrawn yarn obtained at a low spinning speed with the takeup speed of 1500 m/min or below, heat-setting, then deknitting. Such a conventional production method involves complex processes, and undertaking it by increasing the processing speed, etc., is difficult, the product cost is high, and there is the danger of uneven dye spots by the heat-setting treatment.

As a result of an investigation of fibers displaying the crimp and handle of the knit-deknit yarns without the complex knit-deknit yarn production processes, we have discovered that conjugate fibers having a latent crimpability are preferred.

However, when conjugate fibers made simply from polyesters with different limiting viscosity levels (measured in o-chlorophenol at 35°C) are heat-treated, the crimps formed are weak, and are not sufficient for actual use. On the other hand, in Japanese Kokai Patent No. Sho 57[1982]-61716, we had learned that when a conjugate fiber made from (A) a polymer that is

essentially a single polyester and (B) a polymer obtained by adding polyacrylate and/or polystyrene to a polyester base with both components bonded together in many layers is heat-treated, crimps larger than those of the conjugate fiber made from polymers with different limiting viscosity levels described above are formed. The third component added to the polyester base plays a certain role between polyester microfibrils, and the orientation of the polyester base tends to decrease. Therefore, the conjugate fiber formed by bonding polymer A and polymer B together would have a cross section in which portions having a large difference in orientation coexist, and heat treatment would produce large crimps.

However, even the crimps of such conjugate fibers are weak compared with those of conventional knit-deknit yarns, and are not satisfactory for knit goods.

As a result of an intense investigation of ways to use such conjugate fibers in the knit field where the knit-deknit yarns are preferably used, we have discovered that conjugate fibers formed by bonding polymer A and polymer B in many layers with a C-shaped cross section produce larger crimps with a handle similar to the knit-deknit yarns. Thus, the present invention is attained.

Namely, the present invention concerns polyester conjugate fibers characterized by comprising (A) a polymer that is essentially a single polyester and (B) a polymer obtained by adding polymethacrylate and/or polystyrene to a polyester base, with the two polymers being adhered in many layers and satisfying the following conditions (1)-(3):

(1) The conjugate fiber has a C-shaped cross section.

(2) The amount of the additive used with the polyester base is 0.3-5 wt%.

(3) In the cross section of the conjugate fiber, polymer A and polymer B are adhered to each other in at least three layers.

The present invention is explained in further detail with figures.

Figures 1(a)-(d) show various cross-sectional shapes of conjugate fibers obtained by bonding polymer A and polymer B in more than two layers.

Conjugate fibers having the cross-sectional shapes of Figures 1 (a)-(c) produce only weak crimps when heat treated. On the other hand, upon heat treatment, the conjugate fiber having the cross-sectional shape of Figure 1(d) produces large crimps with the handle of the knit-deknit yarns.

Although the reasons for such a difference in crimping are not clear, it seems that the difference is due to the difference in the cross-sectional shape of the conjugate fiber between Figures (a)-(c) and Figure 1(d). Namely, as described above, the conjugate fibers having the cross-sectional shapes of (a)-(c) contain both polymers A and B with different orientations in the same cross section; thus, upon heat treatment, the shrinkage difference between the polymers causes crimping. On the other hand, the conjugate fiber with the cross-sectional shape (d)

contains polymers A and B having different orientations in the same cross section as in the conjugate fibers of the above (a)-(c) and also has cross section anisotropy caused by cooling during the spinning.

When cooling air is blown onto the conjugate fiber as it is ejected from the spinneret, the conjugate fibers with cross-sectional shapes (a)-(c) are exposed to the cooling air uniformly, and the uniform cooling results in a small temperature distribution in the cross section direction. On the other hand, the conjugate fiber with cross-sectional shape (d) would have regions not exposed to cooling, thus cooling is not even and a large temperature distribution is formed in the cross section direction. Yet, in the case of conjugate fibers with a C-shaped cross section, even without a large amount of cooling air, cross-sectional anisotropy can be imparted with cooling air sufficient as to not affect the extruded filaments.

Therefore, upon heat treatment of the conjugate fibers having the cross-sectional shape of Figure 1(d), crimping due to the thermal shrinkage difference between polymers A and B occurs together with the crimping based on the cross-sectional anisotropy caused by cooling. Namely, the crimps are far superior to the conjugate fibers having the cross-sectional shapes in Figure 1(a)-(c) and have the handle of knit-deknit yarns.

In the present invention, the polyester is a linear polyester having at least 85%, preferably 90% or higher, repeating units shown by the general formula [I] shown below:

$$\left(OCH_2-CH_2-O-CO-\langle\bigcirc\rangle-CO \right) \quad \cdots\cdots\cdots \quad (I)$$

and may contain 10 wt% or less additives for the purposes of delustering, dyeability enhancement, antistatic effects, etc. as copolymers or blends.

The polyester has a limiting viscosity (measured in o-chlorophenol at 35°C) of 0.45-1.2, preferably 0.5-1.0.

When the polyester limiting viscosity is below 0.45, fiber breakage tends to occur during spinning and the resulting fibers tend to have low strength. On the other hand, if the limiting viscosity is higher than 1.2, it is necessary to raise the spinning temperature, so this is not favored.

Preferred examples of the polymethacrylate and polystyrene added to the polyester base include polymers of styrene derivatives such as styrene, α-methylstyrene, p-methoxystyrene, vinyltoluene, chlorostyrene, dichlorostyrene, etc.; polymers of methacrylate derivatives such as methyl methacrylate, ethyl methacrylate, etc.; polymers of acrylate derivatives such as methyl acrylate, ethyl acrylate, etc. Of these, preferred in terms of cost are polystyrene and polymethyl methacrylate.

In the present invention, one important point is the conjugate fiber in which (A) a polymer made from a polyester alone and (B) a polymer obtained by adding 0.3-5 wt% of

polymethacrylate and/or polystyrene to polyester are bonded together in more than three layers, and the cross section is C-shaped.

If the amount of the polymethacrylate and/or polystyrene added to the polyester base is less than 0.3 wt%, as described above, lowering of the orientation of the polyester base is not sufficient with a small thermal shrinkage difference from polymer A, thus good crimping is not obtained. On the other hand, if the added amount exceeds 5 wt%, fiber breakage occurs during spinning or breakage occurs frequently; at the same time, the desired effects are leveled off, thus there is no economic merit.

When the number of conjugation layers formed between polymers A and B is only two, a distinct dyeing difference tends to occur easily. On the other hand, when the number of layers between polymers A and B is excessive, the effects displayed individually by each of polymers A and B are offset by each other. The preferred number of layers for obtaining excellent crimps without dyeing differences is 4-22 layers.

Furthermore, unless the conjugate fibers have a C-shaped cross section, even when polymers A and B are bonded in more than two layers in the fiber, as described above, cross-sectional anisotropy cannot be imparted by cooling during spinning, so the heat treatment would not produce sufficient crimping.

In such conjugate fibers, the weight ratio of polymer A and B is preferably 20/80 to 80/20. If the weight ratio deviates from the above range, one of the polymers A and B would become excessive, thus characteristics of the two components can be displayed sufficiently with adverse effects on the crimps and handle of the fiber obtained. Also, poor dye leveling tends to occur.

For obtaining the polyester conjugate fibers of the present invention described above, (A) a polymer comprised of a single polyester and (B) a polymer obtained by adding 0.3-5 wt% of polymethacrylate and/or polystyrene to a polyester are melted separately, then ejected through a spinneret to form a cross section with the shape shown in Figure 1(d). The ejected fiber is cooled by blowing cooling air and at the same time taken up at high speed to obtain a conjugate fiber.

In this melt spinning, the high-speed takeup, e.g., at a rate of 3000 m/min or higher, is preferred for imparting a sufficient orientation difference between polymers A and B in the conjugate fiber.

Next, in drawing the fiber thus obtained, the nondrawn fiber is preheated to a temperature above the glass transition point using a pre-heating roll and drawn in the desired draw ratio, then heat-set immediately before winding without heating or cooling.

According to this method, the strain exerted on the fiber during drawing is set promptly, so, the characteristics possessed by polymers A and B in the same fiber are sufficiently displayed and excellent crimps are formed by heat treatment.

On the other hand, in the conventional drawing process involving, e.g., preheating and drawing a nondrawn fiber, heat setting by a slit heater or plate heater, cooling by a cooling roll, and winding, the strain of drawing disappears, thus the characteristics of the two components cannot be displayed sufficiently and, even upon heat treatment, the crimps formed tend to be weak.

The crimps of the strand from the conjugate fibers of the present invention described above can be developed by the heat treatment in the dyeing process of knit drawn fibers.

This is the most distinct difference between the conventional knit-deknit yarns that are subjected to a complex production process and the conjugate fibers of the present invention. Since the process is simple, the conjugate fibers of the present invention can be prepared at low cost.

After the heat treatment, the handle displayed by the conjugate fibers of the present invention is similar to that of the conventional knit-deknit fibers. Since the handle is not produced mechanically, it feels natural.

Next, the present invention is explained with examples for knit-deknit uses. However, the present invention is not limited to such uses.

APPLICATION EXAMPLES 1-6, COMPARATIVE EXAMPLES 1-5

Polymer (A) comprised of polyethylene terephthalate with a limiting viscosity of 0.64 and polymer (B) made from polyethylene terephthalate treated with polymethyl methacrylate (hereafter referred to as PMMA) or polystyrene (hereafter referred to as PSt) in an amount shown in Table I were spun in the number of layers, fiber cross-sectional shapes and weight ratios of the two polymer components as shown in Table I, then cooled by blowing cooling air at 70 cm/sec and wound at a rate of 3400 m/min.

Next, the nondrawn fibers thus obtained were passed through a preheating roll at 80°C, slit heater at room temperature, and draw roll at 150°C for drawing at a draw ratio 1.5 then wound at a rate of 500 m/min to obtain a 75 de/20 fil drawn yarn.

Next, a sample obtained by crimping the drawn fiber was dyed in a solution of 4% disperse dye (Polyester Eastman Blue) at 100°C and bath ratio of 1/100 for 60 min. The dyed sample was washed with water, dried, and heat-set (180°C, 1 min).

The sample thus obtained was evaluated for crimp and dye leveling. Results are given in Table I.

The crimp and dye leveling were evaluated by visual observation according to the following standards.

(i) Crimp

O: fine crimps formed uniformly all over the knit

ρ: crimps somewhat weak and formed uniformly all over the knit

■: very weak crimp, formation not uniform

(ii) Dye leveling

O: no uneven spots observed

ρ: uneven dye spots visible as very small stripes

■: uneven dye spots visible as large stripes

Table I

	Additive		Number of layers			Weight ratio of the polymers A and B	Cross-sectional shape	Evaluation results	
	Material	Added amount (wt%)	Polymer A	Polymer B	Total			Crimp	Dye ability
Application Example 1	PMMA	0.3	5	6	11	20/80	Figure 1(d)	ρ	O
Application Example 2	PMMA	3	5	6	11	50/50	Figure 1(d)	O	O
Application Example 3	PSt:	5	2	2	4	80/20	Figure 1(d)	O	ρ
Comparative Example 1	PMMA	0.2	2	2	4	50/50	Figure 1(d)	■	O
Comparative Example 2	PMMA	6	2	2	4	50/50	Figure 1(d)	O	■
Application Example 4	PMMA	3	1	2	3	50/50	Figure 1(d)	O	O
Application Example 5	PMMA	3	16	16	32	50/50	Figure 1(d)	O	O
Application Example 6	PMMA	3	32	32	64	50/50	Figure 1(d)	ρ	O
Comparative Example 3	PMMA	3	1	1	2	50/50	Figure 1(d)	■	■
Comparative Example 4	PMMA	3	5	6	11	50/50	Figure 1(b)	■	O
Comparative Example 5	PMMA	3	5	6	11	50/50	Figure 1(c)	■	O

Application Examples 1-6 for the conjugate fibers of the present invention display excellent crimps, with no dye leveling problems.

On the other hand, in Comparative Example 1 with a small amount of PMMA, the orientation difference between the two polymers A and B is not large enough, thus only weak crimps are formed. On the other hand, in Comparative Example 2 with excessive PMMA added, breakage occurs frequently during spinning.

In Comparative Example 3 with just two conjugation layers of polymers A and B, stripe-like dye unleveling is observed due to the difference in dyeability between polymers A and B.

In Comparative Examples 4-5 with different cross-sectional shapes of the conjugate fibers, cross-sectional anisotropy could not be imparted by cooling during spinning, and only weak crimps were formed.

COMPARATIVE EXAMPLES 6-7

Fibers were prepared similarly as in Application Example 2 using polymer B consisting of polyethylene terephthalate free of PMMA or PSt and with the limiting viscosity of the polymer A and B given in Table II. The fiber obtained was knit and evaluated for crimp and dye leveling. Results are given in Table II.

Table II

	Polymer A limiting viscosity	Polymer B limiting viscosity	Number of conjugation layers of polymers A and B	Weight ratio of polymers A and B	Cross-sectional shape	Evaluation results	
						Crimp	Dye unleveling
Comparative Example 6	0.72	0.64	11	50/50	Figure 1(c)	■	○
Comparative Example 7	0.72	0.47	11	50/50	Figure 1(c)	■	○

When polymers A and B are different only in limiting viscosity, a sufficient orientation difference cannot be imparted between the two polymers, thus only weak crimps are formed.

Brief explanation of the figures

Figure 1 is a cross-sectional diagram illustrating the cross-sectional shapes of conjugate fibers formed by bonding polymers A and B in many layers.

In Figure 1,

1: polymer A

2: polymer B

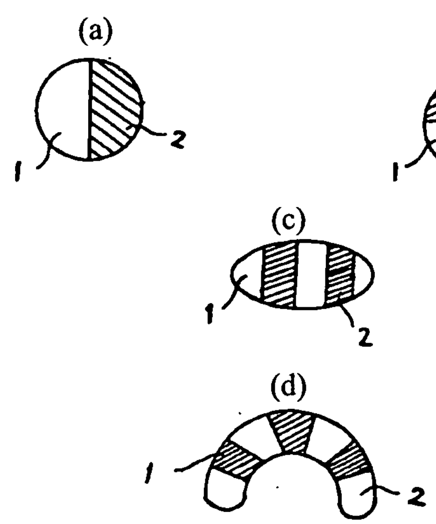

Figure 1